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A SURVEY FOR LIVE MUSSELS IN THE BLACK AND SPRING
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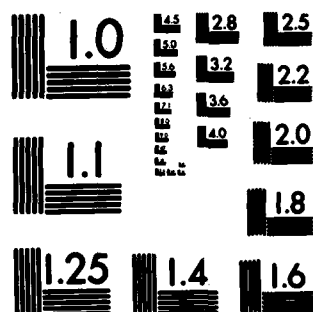
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A SURVEY FOR LIVE MUSSELS IN THE BLACK AND SPRING RIVERS, ARKANSAS, 1985

by

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Prepared for US Army Engineer District, Little Rock
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20. ABSTRACT (Continued).

On the Black River, between miles 68 and 92, 44 collections were made at 22 locations; live mussels were found in 29 of the 44 collections. At seven locations on the river, more than 50 individuals and five species were collected. A total of 29 species of mussels were identified. The fauna was dominated by six species, including *Amblema plicata* (26.13 percent), *Quadrula pustulosa* (25.59 percent), *Fusconaia flava* (11.69 percent), and *F. ebena* (9.21 percent). Uncommon species included *Megalonias gigantea*, *Proptera laevissima*, and *Strophitus subvexus*. The Black River in the study area can be characterized as deep, with moderate current and substrate composed of sand mixed with mud, and various amounts of organic matter. Three gravel bars were identified in the area surveyed; a bar located at mile 73.2 supported a community with high density and species richness.

The Spring River consists of two distinct habitat types, a pool-riffle sequence with sand and gravel between miles 11.0 and 3.2, and a slow-moving, deep-water section with sand and mud substrate between miles 0.0 and 3.2. No living bivalves were found in the lower reach of the river; however, two specimens of *L. orbiculata* were found during a previous study at miles 10.7 and 7.7. Based on earlier work and observations made during this study, it was determined that the upper reach (between miles 11 and 7.0) of the Spring River provides the best habitat for freshwater mussels.

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Preface

From 9 to 12 September 1985 the US Army Engineer Waterways Experiment Station (WES) conducted a survey for live mussels (Mollusca: family Unionidae) on portions of the Black and Spring Rivers, Arkansas. The purpose of this study was to collect information for the Permits Branch, US Army Engineer District, Little Rock (SWL), to be used in making decisions concerning sand and gravel dredging. This report was prepared by Dr. A. C. Miller, WES, and Mr. Paul D. Hartfield, Curator of Invertebrates, Mississippi Museum of Natural Science, Jackson, Miss. Assistance in the field was provided by Mr. Glen Justis, SWL, and Mr. Jim Stewart, US Fish and Wildlife Service, Jackson, Miss. The following divers from the Pine Bluff Resident Office, Arkansas, collected mussels for this study: Mr. Dale Green, Mr. Dale Childers, and Mr. Billy Calloway. The report was edited by Ms. Jessica S. Ruff of the WES Publications and Graphic Arts Division.

This study was conducted under the general supervision of Dr. T. D. Wright, Chief, Aquatic Habitat Group; Dr. C. J. Kirby, Chief, Environmental Resources Division; and Dr. John Harrison, Chief, Environmental Laboratory, WES.

Director of WES was COL Allen F. Grum, USA. Technical Director was Dr. Robert W. Whalin.

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Conversion Factors, Non-SI to SI (Metric)

Units of Measurement

Non-SI units of measurement used in this report can be converted to SI
(metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
feet	0.3048	metres
gallons (US liquid)	3.785412	cubic decimetres
inches	2.54	centimetres
miles (US statute)	1.609347	kilometres

A SURVEY FOR LIVE MUSSELS IN THE BLACK AND SPRING RIVERS,
ARKANSAS, 1985

Introduction

Background

1. On 16-17 November 1983, the Aquatic Habitat Group of the Environmental Laboratory, US Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., conducted a preliminary mussel survey to include areas between miles 68.0 and 92.0 on the Black River and miles 0.0 and 11.0 on the Spring River, northern Arkansas. The work was initiated at the request of the Permits Branch, US Army Engineer District, Little Rock (SWL). The SWL personnel desired information on the presence of endangered mussels for use in evaluating permit requests for sand and gravel dredging. The Black and Spring Rivers are within the reported range of the following endangered mussels: *Lampsilis orbiculata*, *Epioblasma* (= *Dysnomia*) *florentina curtisi*, and *Potamilus* (= *Proptera*) *capax*.

2. The purpose of the survey conducted in the fall of 1983 was to identify sites on the Black and Spring Rivers where there was a potential for finding endangered or uncommon species of mussels. Following completion of the survey, SWL personnel granted a contract to Environmental Research Group (ERG), Inc., of St. Paul, Minn. The purpose of that work was to document the presence or absence of the listed endangered mussels in the study area. The ERG completed their survey in July 1984 and submitted a report to SWL in September 1984. Following receipt of the report, personnel from SWL and the US Fish and Wildlife Service (FWS) decided that inadequate sampling procedures were used by ERG during their survey. Major criticisms of the study conducted by ERG were as follows: (a) too much reliance on the bail for sampling, (b) not enough collections using SCUBA, and (c) lack of clear information on location of sites surveyed.

Purpose and scope

3. The purpose of this study was to collect and identify live mussels (*Mollusca*: family *Unionidae*) at selected sites on the Black River (miles 68.0 to 92.0) and the Spring River (miles 0.0 to 11.0), Arkansas. This study was undertaken specifically to search for live mussels listed as endangered by the

FWS. Information from this survey will be used by SWL personnel to process permits within the study area on the Black and Spring Rivers, Arkansas.

Study area description

4. The areas studied on the Black and Spring Rivers are located in northeastern Arkansas in Lawrence and Randolph Counties. They are approximately on the boundary between the Ozark Plateau to the west and the Mississippi alluvial valley to the east. The Black River originates in southern Missouri, joins the Little Black and Current Rivers near Pocahontas, Ark., then flows southwest and enters the White River near Newport, Ark. The Spring River originates from an underground spring (9 million gal*/hr) at the town of Mammoth Spring, Ark. It joins the Black River at mile 72.1.

5. The study reach on the Black River is south of Pocahontas and includes river miles 68.0 to 92.0. During the period of study, river depths ranged from 3 to 15 ft and widths varied from 150 to 250 ft. Current was moderate in straight reaches (less than 1.0 fps) and greater than 1.0 fps in and immediately below bends. Exposed gravel and cobble bars were noted at miles 73.2, 79.7, and 90.3; at these sites, laminar flow was broken and water was shallow, usually moving at velocities greater than 1.0 fps. Between river miles 71 and about 81, banks were generally low, stable, and vegetated with trees, shrubs, herbs, and grasses. Above river mile 81, banks tended to be steeper and were often unvegetated and partially eroded. With the exception of the sites with gravel and cobble, the majority of the substrate in the Black River consisted of sand mixed with mud and organic material.

6. The Spring River from mile 11.0 at Imboden, Ark., to about 1 mile below its confluence with the Eleven Point River can be characterized as pool-riffle habitat with sand and gravel substrate. From about 1 mile below the mouth of the Eleven Point River to its confluence with the Black River, current was slow, depth was 11 to 12 ft, and the substrate consisted of sand mixed with mud.

Sampling sites

7. Prior to conducting fieldwork, tentative sampling sites in the study area were chosen by consulting US Geological Survey topographic maps and the studies by ERG (Zimmerman et al. 1984) and WES (Miller and Nelson 1984).

* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

As the fieldwork progressed, additional sampling sites were added as appropriate. A total of 44 sites were searched for mussels on the Black River between 9 and 12 September 1985 (see Figure 1).

8. Quantitative substrate samples using a 0.25-sq m (2.7-sq ft) quadrat were taken by divers on 11 and 12 September. Thirty-eight quadrat samples were obtained from two sites on the left bank of the Black River at mile 73.2. At this location, samples were obtained along a cable placed perpendicular to the shoreline and running into the mussel bed. A pair of samples was taken at points separated by 5 ft along the cable. Fourteen of these samples were collected at the downriver transect (Site I); 24 samples were obtained along a transect placed 200 ft upriver (Site II). Six quantitative samples were obtained on the right bank of the Black River at mile 75.05 (Site III) on 12 September.

9. It was decided that intensive searches for live mussels would not be conducted at sites on the Spring River where live *L. orbiculata* had been collected by ERG. Intensive searches for mussels were conducted only between the confluence of the Eleven Point River and mile 0.0 on the Spring River. In addition a general shell survey was conducted between the Eleven Point River and about mile 6.0 on the Spring River. Live *L. orbiculata* were collected by ERG at miles 11 and 7, and shells of this species were found in the river between miles 11 and 3 by Miller and Nelson (1984) and Zimmerman et al. (1984). Since that portion of the river provided habitat for the species, no further sampling was conducted.

Sampling methods

10. Qualitative searches for mussels were made by a three-man diving crew provided by SWL. They used either scuba or surface air supply with communications equipment. The diving crew worked in deep water (greater than 6 ft) or when current velocities exceeded 1.0 fps. Three men with snorkeling gear searched for live mussels in shallow shoreline areas where current was moderate. Occasionally the diving crew and snorkelers searched the same sites.

11. For qualitative searches, divers and snorkelers were instructed to retrieve all live organisms that were encountered. Specific sites were searched for at least 15 min. If mussels were found, an additional 15 to 60 min was spent at the site, depending on the size of the bed encountered. Live *L. orbiculata* were replaced in the substrate by the divers; all other mussels were thrown back in the water.

12. Quantitative collections for mussels were made by removing all shells, substrate, mussels, etc., to a depth of 3 to 4 in. within the confines of a 0.25-sq m quadrat. The substrate was brought to the surface in a 5-gal bucket by the diver, the contents sieved, and all live organisms removed. All mussels were identified, and total length (in millimetres) and weight (in grams) were recorded. Quantitative sampling was conducted to: (a) obtain information on community and population dynamics, and (b) search for juvenile mussels (prereproductive organisms less than 3 to 4 cm (1.2 to 1.6 in.) long) which are usually missed during qualitative searches.

Mussels of the area

13. After reviewing much of the molluscan literature in Arkansas, Gordon, Kraemer, and Brown (1979) determined that 38 species of unionids inhabited the Black River and 37 species were in the Spring River. In their 1984 survey, Zimmerman et al. collected or observed 34 species in the Spring River and 31 species in the Black River. On a 2-day survey in which only shells were collected, Miller and Nelson (1984) identified 36 species in the Black River and 34 species in the Spring River.

14. Mussel fauna of these two rivers consists mainly of thick-shelled species which tolerate sand and gravel substrate. These species include representatives of the following genera: *Quadrula*, *Tritogonia*, *Cyclonaias*, and *Fusconaia*. The only endangered species that has been found in either river is *L. orbiculata*.

15. Historically, *L. orbiculata* occurred sparingly, over a wide area. This included the Niagara River at Buffalo, N. Y.; the Illinois River in Illinois; the Ohio River (lower and upper portions) and some of its tributaries (Allegheny, Monongahela, Kanawha, Muskingum, Scioto, Green, Wabash, and White Rivers); the Cumberland and a tributary (Obey River); and the Tennessee River and some of its tributaries (Clinch, Holston, French Broad, Flint, Duck River, and Limestone Creek). It has been found in the Ohio, Muskingum, and Green Rivers; in the Cumberland River in Wilson, Truesdale, and Smith Counties, Tenn.; and in the lower Tennessee River below Wilson and Guntersville Dams in Alabama, and below Pickwick Dam in Tennessee. It has also been collected in the Meramec River basin (Buchanan 1980).

16. Parmalee (1967) reported that, in Illinois, *L. orbiculata* was uncommon to rare and taken only from large rivers in deep water. Buchanan (1980) reported that this species was found in a variety of substrates ranging

from silt to cobble but was commonly found in a gravel-cobble substrate. In the Buchanan study, *L. orbiculata* was collected in 1 to 5 ft of water with currents ranging from 0.0 to 1.2 fps at the bottom. This species was always collected among concentrations of other naiads. *L. orbiculata* comprised only 0.1 percent of the living mussels found in the Meramec River basin (Buchanan 1980).

Results and Discussion

Mussels - Black River

17. Initially, the divers were instructed to sample a series of transects perpendicular to the shoreline moving from deep (in the channel) to shallow water. It became immediately apparent that, in the Black River, mussels were restricted to fairly narrow strips along the banks. The mussels were in water ranging from <1 to 10 ft deep and from 1 to 30 ft from shore. No live mussels were collected in the channel. Mussels were usually found where flow was moderate in straight reaches of river directly above or below a bend.

18. A total of 1,129 live mussels representing 26 species were collected during the 4-day survey on the Black River (Tables 1-8, Figure 1). Live mussels were found in 29 of the 44 collections. At the following river miles on the Black River, more than five species and 50 individuals were collected.

<u>Black River, mile</u>	<u>Bank</u>
73.2	Left
73.6	Left
75.05	Right
75.1-75.2	Right
79.7	Left
80.6	Right
81.6	Left

The sites where good mussel communities were found had substrate that consisted of sand and gravel (mile 73.2), silt and sand (miles 73.6 and 80.6), or sand mixed with mud, silt, and organic matter (miles 75.05, 75.1, 79.7, and 81.6). Based upon results of the 4-day survey, the largest mussel bed on the Black River was the sand and gravel shoal on the left bank at river mile 73.2, where a total of 20 species were collected. This community had a large number of organisms that were either uncommon or not present at upriver

sites, such as *Arcidens confragosus*, *Cyclonaias tuberculata*, *Obliquaria reflexa*, *Quadrula cylindrica*, and *Quadrula quadrula*.

19. Based upon qualitative collections, the Black River mussel community is dominated by two species found in approximately equal numbers, *Amblema plicata* and *Quadrula pustulosa* (Table 1). *Ellipsaria lineolata*, *Fusconaia flava*, *F. ebena*, *O. reflexa*, *Q. cylindrica*, and *Q. quadrula* were fairly common. The remaining 18 species were judged to be uncommon.

20. In the study area on the Black River, mussel species diversity decreased in the middle to upper portions (Figure 2). Extensive mussel beds with high density were not found between the town of Pocahontas and river mile 81.6 (Tables 2-7). The upper section of the study area did not provide good habitat for mussels when compared with the lower portion; above river mile 81.6 there appeared to be little stable sand/gravel substrate. A stable sand and gravel bar with live mussels was found north of the highway bridge at Pocahontas. However, diversity and density of molluscs were low, and shells and live specimens were old and badly eroded. Based upon shell collections only, Miller and Nelson (1984) reported 17 species and Zimmerman et al. (1984) reported 16 species from the site. The reason for mussel decline at the bar near Pocahontas is not known.

Mussels - Spring River

21. The divers searched four sites for live mussels in the Spring River (Figure 1). These sites were at miles 0.5, 0.9, 1.3, and 2.4. No mussels were found, and it was determined that substrate was unsuitable. Above the Eleven Point River (which deposits a high sediment load in the lower Spring River), the Spring River provides high-quality mussel habitat with stable sand and gravel substrate. Commercial clamming is still being done on the Spring River; a shell fisherman was observed working a site near mile 8.0. No live *L. orbiculata* were collected in the Spring River during this survey.

L. orbiculata - study area

22. During the 4-day survey, *L. orbiculata* was collected at two sites on the Black River (Tables 2, 3, 5, 6; Figure 2). At mile 75.05 the substrate consisted of sand and silt mixed with organic matter; the water was 8 to 10 ft deep and current was slow. The bed where it was found supported only six other species. At mile 80.7, *L. orbiculata* was collected in water less than 6 ft deep where the substrate consisted of sand and mud and the current was moderate. The density at this site was less than one individual per square

metre, and a total of seven species were collected. Although no live *L. orbiculata* were collected in the Spring River during this survey, Zimmerman et al. (1984) collected live *L. orbiculata* at Spring River miles 7.7 and 10.7. In addition, Miller and Nelson (1984) collected shells of this species near Imboden at mile 11.0. Based upon the results of this and previous surveys, the most valuable habitat for *L. orbiculata* and mussels in general is between miles 11.0 and about one mile below the confluence of the Elevation Point River.

23. Based upon the above literature and the results of this survey, it appears that *L. orbiculata* inhabits medium to large rivers with moderate current (less than 1 fps). It is found in a variety of substrate types, ranging from sand and organic matter (the Black River) to sand and gravel (the Spring River). While it has been reported from deep water, it can be taken in depths less than 6 ft deep. In the Spring River, it exists in pool-riffle habitat, while in the Black River it is found in straight reaches of the river with moderate flow.

Quantitative samples

24. A total of 14 and 24 quantitative samples for mussels were taken along two transects in a mussel bed at mile 73.2 (Sites I and II, Figure 1). Six randomly placed quadrat samples were taken at mile 75.05 (Site III, Figure 1). Site I had a high-quality sand gravel substrate; 14 species with an average density of 19.4 individuals/sq m were recorded (Tables 8 and 9). At Site II, the substrate changed from sand to sand/gravel approximately halfway through the transect. Densities averaged 4.5 individuals/sq m, and 10 species were collected (Figure 3).

25. Site III (mile 75.05) had the lowest density of unionids (3.3/sq m) and the highest density of *Corbicula* (25.3/sq m). Although this location provided good species richness and at least one live *L. orbiculata*, it was characterized by a large number of old specimens. However, evidence of recent recruitment was noted; a single *Q. pustulosa* (total length 13.9 mm) was collected. The substrate at Site III consisted of sand and mud with no gravel and large amounts of stems, bark, and partially decayed leaves. Based upon qualitative collections, *Q. pustulosa* (25.95 percent) and *A. plicata* (26.13 percent) were approximately equal. Figures 4-11 depict habitat conditions, common unionids, and collection techniques used during this survey.

Unionid recruitment - Black River

26. Evidence of recent recruitment was noted for 11 of the 26 species of unionids collected in the Black River during the 4-day survey. Information on recruitment came from quantitative sampling at Sites I and II (river mile 73.2) and Site III (river mile 75.05). An additional four species had representatives that were judged to be subadult based on qualitative collections. As indicated below, juveniles typically comprised 20 to 40 percent of the population.

<u>Species</u>	<u>Total Collected</u>	<u>% <30 mm</u>	<u>Maximum Size, mm*</u>
<i>Amblema plicata</i>	13	38.5	120.4
<i>Cyclonaias turberculata</i>	7	28.6	67.1
<i>Fusconaia ebena</i>	10	40.0	86.2
<i>Fusconaia flava</i>	15	26.7	80.2
<i>Quadrula pustulosa</i>	23	29.1	67.2

* Collected during this survey.

27. The Black River in the area studied exhibited moderate recruitment when compared to the other sites. In a gravel bar on the Ohio River at Olmsted, Ill., juvenile *F. ebena* outnumbered adults three to one (Miller and Payne 1983). However, in the East Channel of Prairie du Chien, Wis., Miller, Payne, and Hartfield (1984) determined that juvenile *A. plicata* comprised about 30 percent of the adult population. The presence of juveniles indicates that physical and biological conditions are suitable to support a recruiting community of bivalves.

Summary

28. In the study area on the Black River, the mussels are restricted to fairly narrow strips along the shore where current is moderate and substrate consist of sand, mud, and gravel. While the molluscan fauna is not extensive, there are at least seven high-quality beds and numerous other areas where from one to five species were found. In addition, evidence of recent recruitment was noted in the Black River for 11 of the 26 species collected.

29. There were two locations on the Black River where *L. orbiculata* was collected, at miles 75.05 and 80.6. Because of species richness and, in two cases, presence of an endangered species, these sites should be protected from commercial sand and gravel dredging. In addition, the sites noted previously (miles 73.6, 75.1, 79.7, and 81.6) support extensive mussel communities. Based upon results of the present and previous surveys, the most valuable mussel habitat on the Black River is between miles 73.2 and 81.6. This reach of river supports the densest and most diverse communities, as well as live *L. orbiculata*. The portion of the study area between miles 81.6 and 92.0 supported live mussels, although species diversity and density were less than in the lower section of the study area. *L. orbiculata* has not been found in the reach of the river; however, suitable habitat does occur and this species could exist.

30. The best mussel habitat in the Spring River is located between miles 11.0 and 3.2. In this river reach, the substrate consisted of sand and gravel, and the mussel community was diverse and did support live *L. orbiculata*. No live mussels or endangered species were collected on the lower reach of the Spring River (miles 0.0 to 3.2), and no suitable habitat was observed.

31. Extensive mussel beds and/or the presence of *L. orbiculata* were noted at the following locations on the Black and Spring Rivers:

<u>River</u>	<u>River Mile</u>
Black	73.2
	73.6
	75.05
	75.1-75.2
	79.7
	80.6
	81.6
Spring	7.7
	10.7
	11.0

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Table 1
Live Mussels Collected from the Black River, Arkansas,
River Miles 71-92, 9-12 September 1985

Species	Mussels			Sites		Evidence of Recent Recruitment
	Total	Percent	Rank	Total	Percent	
<i>Actinonais ligamentina</i>	10	0.88	12	4	14	No
<i>Amblema plicata</i>	295	26.13	1	17	59	Yes
<i>Arcidens confragosus</i>	2	0.18	21	1	3	No
<i>Cyclonaias tuberculata</i>	10	0.88	12	1	3	Yes
<i>Cyprogenia aberti</i>	3	0.26	19	2	7	Yes
<i>Ellipsaria lineolata</i>	79	7.00	5	8	28	Yes
<i>Elliptio dilatata</i>	2	0.18	21	2	7	No
<i>Fusconaia ebena</i>	104	9.21	4	13	45	Yes
<i>Fusconaia flava</i>	132	11.69	3	13	45	Yes
<i>Lampsilis orbiculata</i>	2	0.18	21	2	7	No
<i>Lampsilis ventricosa</i>	5	0.44	18	5	17	No*
<i>Lasmigona complanata</i>	1	0.009	24.5	1	3	No
<i>Leptodea fragilis</i>	8	0.71	15	4	14	Yes
<i>Megalonaias gigantea</i>	1	0.009	24.5	1	3	No
<i>Obliquaria reflexa</i>	39	3.45	7	8	28	Yes
<i>Plectomerus dombejanus</i>	6	0.53	16.5	4	14	No
<i>Proptera laevisissima</i>	1	0.009	24.5	1	3	No
<i>Proptera purpurata</i>	13	1.15	10	7	24	No*
<i>Quadrula cylindrica</i>	55	4.87	6	4	14	No*
<i>Quadrula metanevra</i>	14	1.24	9	3	10	No
<i>Quadrula nodulata</i>	6	0.53	16.5	4	14	No
<i>Quadrula pustulosa</i>	293	25.95	2	20	69	Yes
<i>Quadrula quadrula</i>	28	2.48	8	8	28	Yes
<i>Tritogonia verrucosa</i>	10	0.88	12	7	24	No*
<i>Truncilla truncata</i>	9	0.80	14	3	10	Yes
<i>Strophitus subvexus</i>	1	0.009	24.5	1	3	No
Total mussels	1,129					
Total species	26					
Total sites surveyed	44					
Total sites with mussels	29					

* Denotes subadults, although no juveniles were collected.

Table 2
Live Mussels Collected from the Black River, Arkansas, 9 September 1985

Species	Site No.							
	3	4	5	6	7	9	10	11
<i>Actinonais ligamentina</i>	--	--	1	--	--	--	--	1
<i>Amblema plicata</i>	2	21	1	27	5	28	11	37
<i>Arcidens confragosus</i>	--	--	--	--	--	--	--	2
<i>Cyclonaias tuberculata</i>	--	--	--	--	--	--	--	10
<i>Cyprogenia aberti</i>	1	--	--	--	--	--	--	2
<i>Ellipsaria lineolata</i>	1	2	--	34	--	--	16	19
<i>Elliptio dilatata</i>	--	--	--	--	--	--	--	1
<i>Fusconaia ebena</i>	--	3	--	2	--	--	7	33
<i>Fusconaia flava</i>	--	18	--	25	4	2	7	50
<i>Lampsilis orbiculata</i>	--	--	--	--	1	--	--	--
<i>Lampsilis ventricosa</i>	--	--	1	--	--	--	--	1
<i>Lasmigona complanata</i>	--	--	--	--	--	--	--	1
<i>Leptodea fragilis</i>	--	--	--	--	--	--	--	4
<i>Megalonaias gigantea</i>	--	--	--	1	--	--	--	--
<i>Obliquaria reflexa</i>	--	2	--	2	--	--	1	15
<i>Plectomerus dombeyanus</i>	--	--	1	1	--	--	--	--
<i>Proptera laevisissima</i>	--	--	--	--	--	--	--	--
<i>Proptera purpurata</i>	--	2	--	3	--	--	--	--
<i>Quadrula cylindrica</i>	--	8	--	17	--	1	--	29
<i>Quadrula metanevra</i>	--	--	--	--	1	--	--	4
<i>Quadrula nodulata</i>	--	--	--	--	--	--	--	2
<i>Quadrula pustulosa</i>	--	9	--	14	1	12	15	147
<i>Quadrula quadrula</i>	--	--	--	--	1	--	2	18
<i>Tritogonia verrucosa</i>	--	2	--	3	--	--	1	1
<i>Truncilla truncata</i>	--	--	--	--	--	--	1	7
<i>Strophitus subvexus</i>	--	--	--	--	--	--	--	--
Total species	3	9	4	11	6	4	9	20
Total mussels	4	67	4	129	13	43	61	384

Note: See Table 5 for more information on these sites.

Table 3

Live Mussels Collected from the Black River, Arkansas, 10 September 1985

Species	Site No.												
	13	15	19	20	23	24	25	26	27	29	30	31	32
<i>Actinonais ligamentina</i>	--	--	2	--	--	--	7	--	1	--	--	--	--
<i>Amblema plicata</i>	--	--	2	--	--	--	37	--	1	79	--	28	--
<i>Arcidens confragosus</i>	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Cyclonaias tuberculata</i>	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Cyprogenia aberti</i>	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Ellipsaria lineolata</i>	--	--	--	--	--	--	4	--	--	--	--	2	--
<i>Elliptio dilatata</i>	--	--	--	--	--	--	1	--	--	--	--	--	--
<i>Fusconaia ebena</i>	--	--	4	--	--	--	27	--	3	1	--	13	--
<i>Fusconaia flava</i>	--	--	2	--	--	--	11	--	1	7	--	--	--
<i>Lampsilis orbiculata</i>	--	--	--	--	--	--	--	--	--	--	--	1	--
<i>Lampsilis ventricosa</i>	--	--	--	--	--	--	--	1	--	--	1	--	--
<i>Lasmigona complanata</i>	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Leptodea fragilis</i>	--	--	--	--	--	--	2	--	--	--	--	--	--
<i>Megalonaias gigantea</i>	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Obliquaria reflexa</i>	--	--	1	--	--	--	12	--	--	2	--	4	--
<i>Plectomerus dombeyanus</i>	--	--	--	--	--	--	--	--	--	1	--	--	--
<i>Proptera laevisissima</i>	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Proptera purpurata</i>	1	1	--	--	--	--	2	--	--	2	--	--	--
<i>Quadrula cylindrica</i>	--	--	--	--	--	--	--	--	--	--	--	--	--
<i>Quadrula metanevra</i>	--	--	--	--	--	--	9	--	--	--	--	--	--
<i>Quadrula nodulata</i>	--	--	--	--	--	--	1	--	--	1	--	2	--
<i>Quadrula pustulosa</i>	--	--	7	1	2	1	20	--	7	20	--	8	1
<i>Quadrula quadrula</i>	--	--	--	--	--	--	1	--	1	--	--	--	--
<i>Tritogonia verrucosa</i>	--	--	--	--	--	--	1	--	--	1	--	--	--
<i>Truncilla truncata</i>	--	--	--	--	--	--	1	--	--	--	--	--	--
<i>Strophitus subvexus</i>	--	--	--	--	--	--	1	--	--	--	--	--	--
Total species	1	1	5	1	1	1	16	1	6	9	1	7	1
Total mussels	1	1	16	1	2	1	137	1	14	114	1	58	1

Note: See Table 6 for more information on these sites.

Table 4

Live Mussels Collected from the Black River, Arkansas, 11 September 1985

Species	Site No.							
	33	36	37	38	39	40	41	42
<i>Actinonais ligamentina</i>	--	--	--	--	--	--	--	--
<i>Amblema plicata</i>	--	--	9	5	--	1	1	--
<i>Arcidens confragosus</i>	--	--	--	--	--	--	--	--
<i>Cyclonaias tuberculata</i>	--	--	--	--	--	--	--	--
<i>Cyprogenia aberti</i>	--	--	--	--	--	--	--	--
<i>Ellipsaria lineolata</i>	--	--	--	--	--	--	1	--
<i>Elliptio dilatata</i>	--	--	--	--	--	--	--	--
<i>Fusconaia ebena</i>	--	6	--	2	--	--	1	2
<i>Fusconaia flava</i>	--	1	3	--	--	--	--	1
<i>Lampsilis orbiculata</i>	--	--	--	--	--	--	--	--
<i>Lampsilis ventricosa</i>	--	--	--	1	--	--	--	--
<i>Lasmigona complanata</i>	--	--	--	--	--	--	--	--
<i>Leptodea fragilis</i>	1	--	--	--	1	--	--	--
<i>Megalonaias gigantea</i>	--	--	--	--	--	--	--	--
<i>Obliquaria reflexa</i>	--	--	--	--	--	--	--	--
<i>Plectomerus dombeyanus</i>	3	--	--	--	--	--	--	--
<i>Proptera laevis</i>	--	--	--	--	--	1	--	--
<i>Proptera purpurata</i>	--	1	--	--	--	--	2	--
<i>Quadrula cylindrica</i>	--	--	--	--	--	--	--	--
<i>Quadrula metanevra</i>	--	--	--	--	--	--	--	--
<i>Quadrula nodulata</i>	--	--	--	--	--	--	--	--
<i>Quadrula pustulosa</i>	--	2	8	14	1	3	--	--
<i>Quadrula quadrula</i>	4	1	--	--	--	--	--	--
<i>Tritogonia verrucosa</i>	--	--	--	--	--	--	--	1
<i>Truncilla truncata</i>	--	--	--	--	--	--	--	--
<i>Strophitus subvexus</i>	--	--	--	--	--	--	--	--
Total species	4	4	3	4	2	3	4	3
Total mussels	8	10	20	22	2	5	5	4

Note: See Table 7 for more information on these sites.

Table 5
Sites Surveyed for Mussels on the Black River, Arkansas
9 September 1985

River Mile	Bank	Site No.	Method*	Mussels		Notes
				Species	Individuals	
75.1	Center	1	D(10)	--	--	Current swift, sub- strate sand, gravel
75.1	Right	2	D(10)	--	--	Live mussels present, none collected
75.2	Right	3	D(15)	3	4	Bedrock, gravel substrate
75.1	Right	4	S	9	67	Gravel, cobble, cypress roots
75.15	Right	5	D(15)	4	4	Mussels old, well worn
75.05	Right	6	S	11	129	Downriver of a large sycamore tree, shells worn
75.05	Right	7	D(15), S	6	13	One live <i>L. orbiculata</i>
75.1	Left	8	D(15)	--	--	Directly across from sycamore tree
75.15	Left	9	S	4	43	Snags, mud, sand substrate
73.6	Left	10	D(20), S	9	61	A good site for mussels
73.2	Left	11	D(35), S	20	384	The best site on this section of the river for mussels; cobble, sand, gravel bar

* D = dive (dive time in minutes); S = snorkel.

Table 6
Sites Surveyed for Mussels on the Black River, Arkansas
10 September 1985

River Mile	Bank	Site No.	Method*	Mussels		Notes
				Species	Individuals	
76.4	Left	12	D(10)	--	--	Sand, mud, swift current
76.4	Right	13	S	1	1	Sand, mud, swift current
76.3	Left	14	D(8)	--	--	Sand, mud, swift current
76.3	Right	15	S	1	1	Sand, mud, swift current
76.5	Left	16	S	--	--	No shells, sandy substrate
76.6	Left	17	D(10)	--	--	Sand, gravel substrate
76.6	Right	18	S	--	--	Sand, gravel substrate
77.4	Left	19	D(20)	5	16	Sand, mud substrate
78.3	Right	20	S	1	1	Sand substrate
78.3	Left	21	D(6)	--	--	Sand, no shells
78.4	Right	22	S	--	--	Sand, mud
78.5	Left	23	D(13)	1	2	Sand, mud
79.4	Right	24	D(7)	1	1	Sand, mud
79.7	Right	25	D(40)	16	137	Cobble, gravel, bar
80.6	Left	26	D(10)	1	1	Sand substrate
81.5	Right	27	D(15)	6	14	Clay, mud
81.5	Left	28	D(10)	--	--	--
81.6	Left	29	S	9	114	--
83.6	Left	30	D(15)	1	1	Sand, shallow water
80.6	Right	31	D(12), S	7	58	One live <i>L. orbiculata</i> collected
84.6	Right	32	D(10)	1	1	Snags, mud, and sand

* D = dive (dive time in minutes); S = scuba.

Table 7
Sites Surveyed for Mussels on the Black River, Arkansas
11 September 1985

River Mile	Bank	Site No.	Method*	Mussels		Notes
				Species	Individuals	
85.4	Right	33	D(17), S	4	8	Fairly good site for mussels
86.2	Left	34	D(12)	--	--	Sand
85.7	Right	35	S	--	--	Sand
86.6	Left	36	S	4	10	<i>F. flava</i> : length = 10.3 mm
86.9	Right	37	D(15)	3	20	Fairly good site for mussels
87.4	Left	38	S	4	22	<i>L. ventricosa</i> : length = 151.9 mm; height = 109 mm; thickness = 80.0 mm
88.8	Left	39	D(15)	2	2	Stable banks, 4-8 ft high
88.2	Left	40	S	3	5	<i>Corbicula</i> : length = 35.7
90.3	Right	41	D(18), S	4	5	Directly about gravel bar visible from Hwy 67 Bridge
90.4	Right	42	D(10)	3	4	Bedrock, cobble, and gravel sub- strate; many old shells were observed
90.4	Left	43	D(10)	--	--	No shells or live mussels were ob- served
90.6	Right	44	D(10)	--	--	Stable, well- vegetated bank
Total species				26		
Total sites with live mussels				29		
Total mussels				1,129		

* D = dive (dive time in minutes); S = snorkel.

Table 8
Mussels Collected from 0.25-sq m Quantitative Samples Collected
on the Black River, Arkansas, 11-12 September 1985*

Species	Site No.					
	I		II		III	
	No.	%	No.	%	No.	%
<i>Actinonais carinata</i>	--	--	1	3.3	--	--
<i>Amblema plicata</i>	10	12.5	1	3.3	2	4.6
<i>Cyclonaias tuberculata</i>	5	6.2	2	6.7	--	--
<i>Ellipsaria lineolata</i>	2	2.5	1	3.3	--	--
<i>Fusconaia ebena</i>	7	8.7	3	10.0	--	--
<i>Fusconaia flava</i>	13	16.2	2	6.7	1	2.3
<i>Lampsilis ventricosa</i>	1	1.2	--	--	--	--
<i>Obliquaria reflexa</i>	2	2.5	1	3.3	--	--
<i>Proptera purpurata</i>	2	2.5	1	3.3	--	--
<i>Quadrula cylindrica</i>	3	3.7	2	6.7	--	--
<i>Quadrula pustulosa</i>	8	10.0	13	43.3	2	4.6
<i>Quadrula quadrula</i>	1	1.2	--	--	--	--
<i>Tritogonia verrucosa</i>	3	3.7	--	--	--	--
<i>Truncilla truncata</i>	11	13.7	--	--	--	--
<i>Corbicula</i>	12	15.0	3	10.0	38	88.4
Total species	14		11		4	
Total individuals	80		30		43	
Total unionids	68		27		5	
Total 0.25-sq m quadrats	14		24		6	
Average unionid density (per square metre)	19.4		4.5		3.3	

* See Figure 1 for locations of Sites I-III.

Table 9
Unionid Densities at Site I, River Mile 73.2 on the Black River
12 September 1985

<u>Species</u>	<u>Average No./sq m</u>	<u>Number of Quadrats with Individuals Present</u>
<i>Actinonais ligamentina</i>	--	--
<i>Amblema plicata</i>	2.9	7
<i>Cyclonaias tuberculata</i>	1.4	5
<i>Ellipsaria lineolata</i>	0.6	2
<i>Fusconaia ebena</i>	2.0	4
<i>Fusconaia flava</i>	3.7	9
<i>Lampsilis ventricosa</i>	0.3	1
<i>Obliquaria reflexa</i>	0.6	2
<i>Proptera purpurata</i>	0.6	1
<i>Quadrula cylindrica</i>	0.8	3
<i>Quadrula pustulosa</i>	2.3	6
<i>Quadrula quadrula</i>	0.3	1
<i>Tritogonia verrucosa</i>	0.8	2
<i>Truncilla truncata</i>	3.1	7
<i>Corbicula</i>	3.4	5
 No. of quadrat samples	 14	
Average unionid density	19.4	

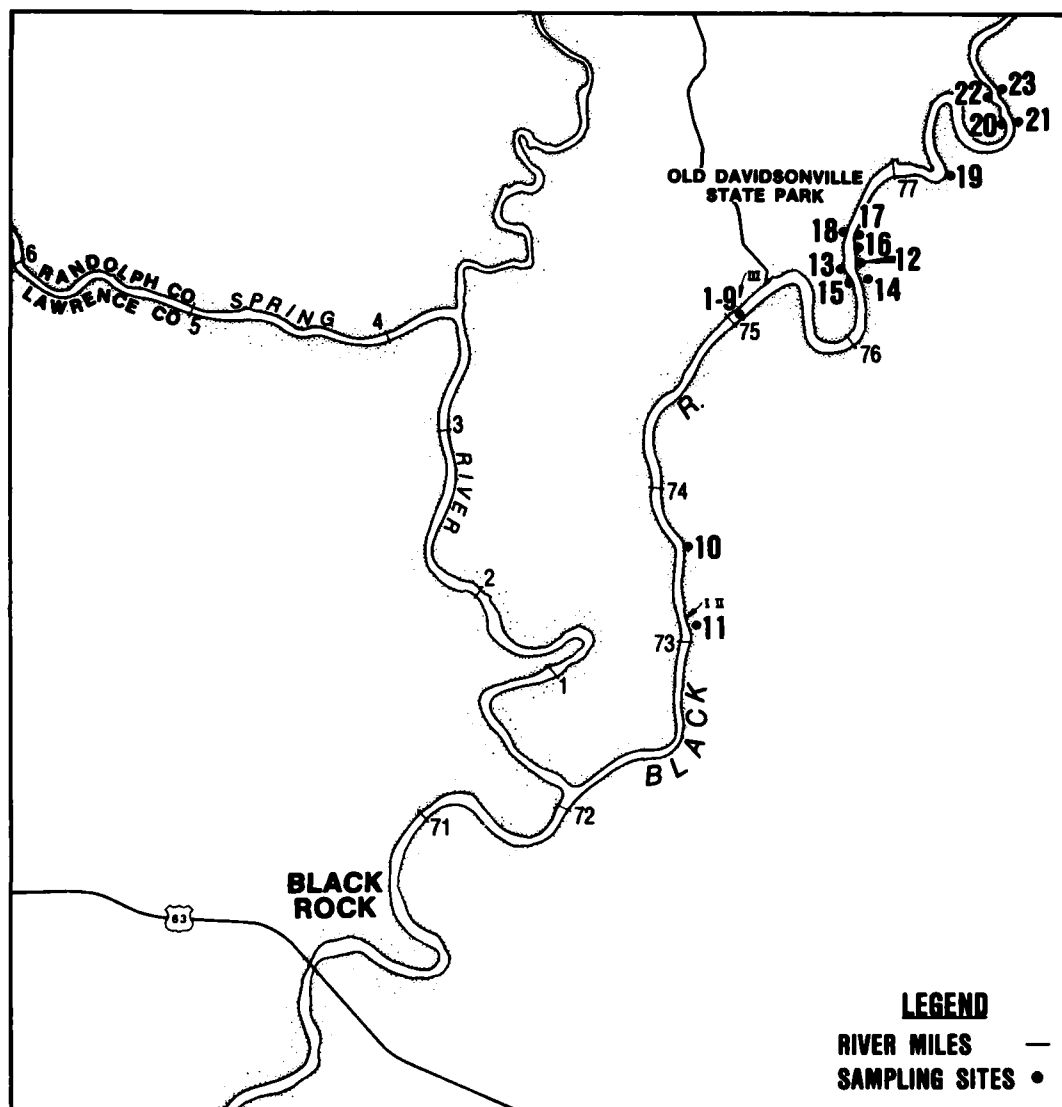


Figure 1. Sites surveyed for live mussels on the Black River, Lawrence and Randolph Counties, Ark., 9-12 September 1985 (substrate sampling sites are numbered I, II, and III) (Continued)

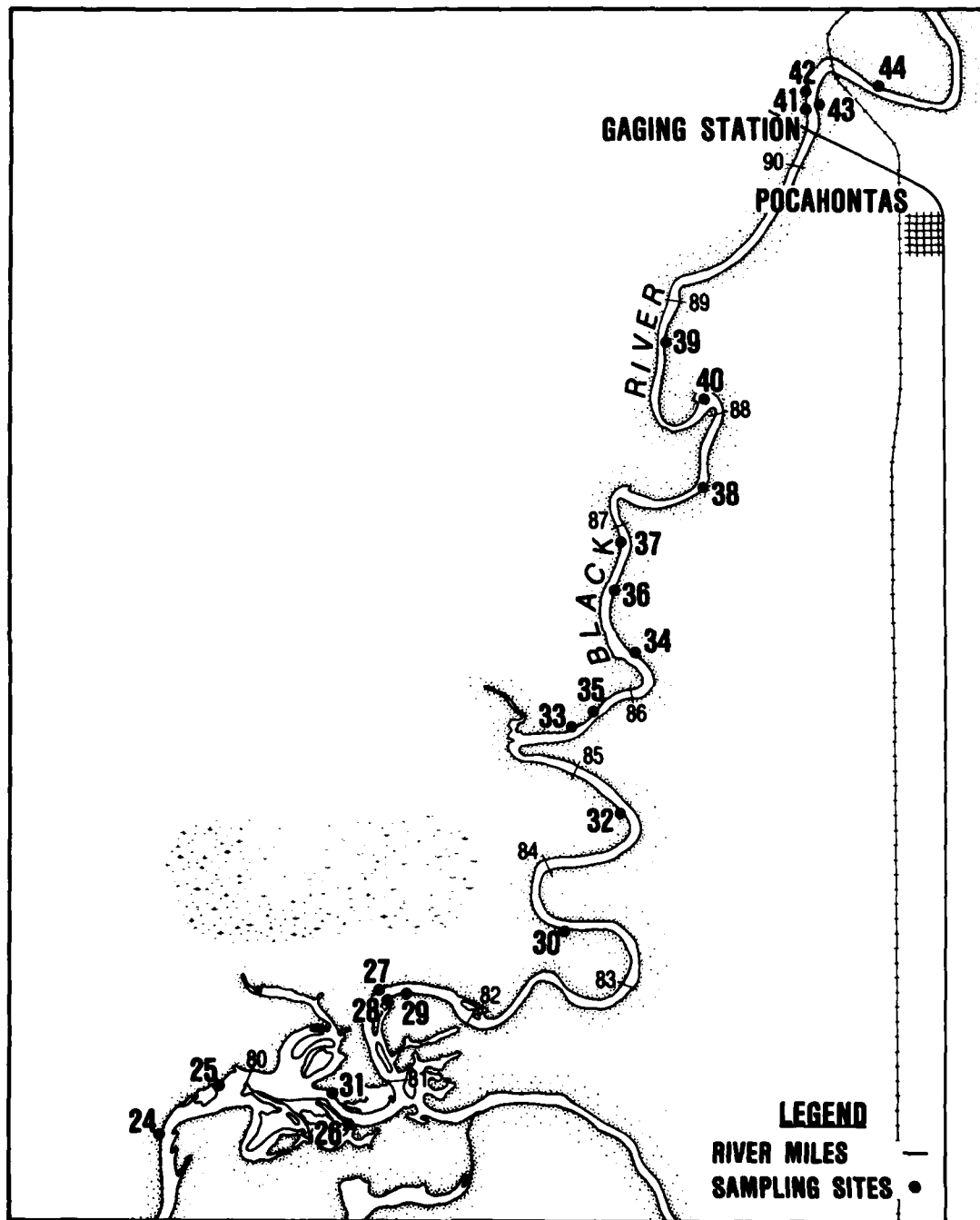


Figure 1. (Concluded)

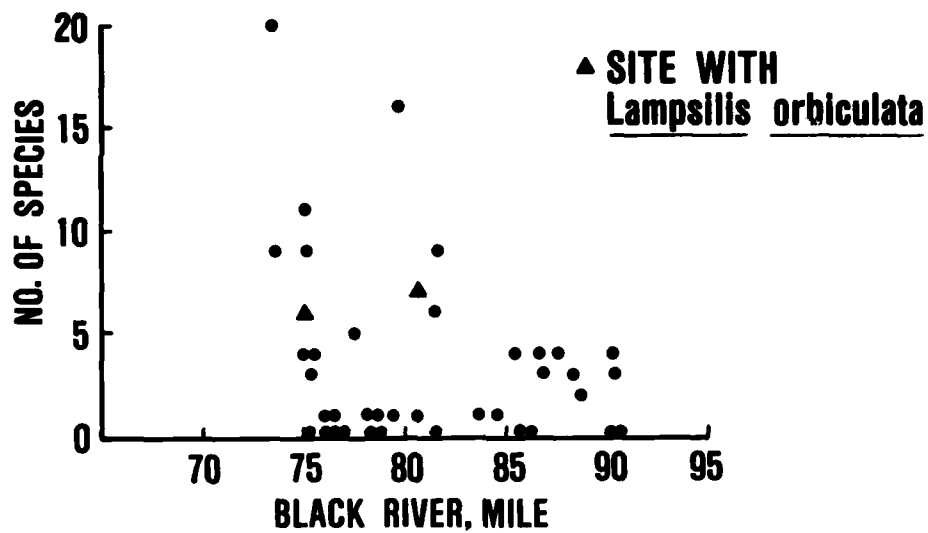


Figure 2. Total species collected and sites with live *L. orbiculata*, Black River, Arkansas, 9-12 September 1985

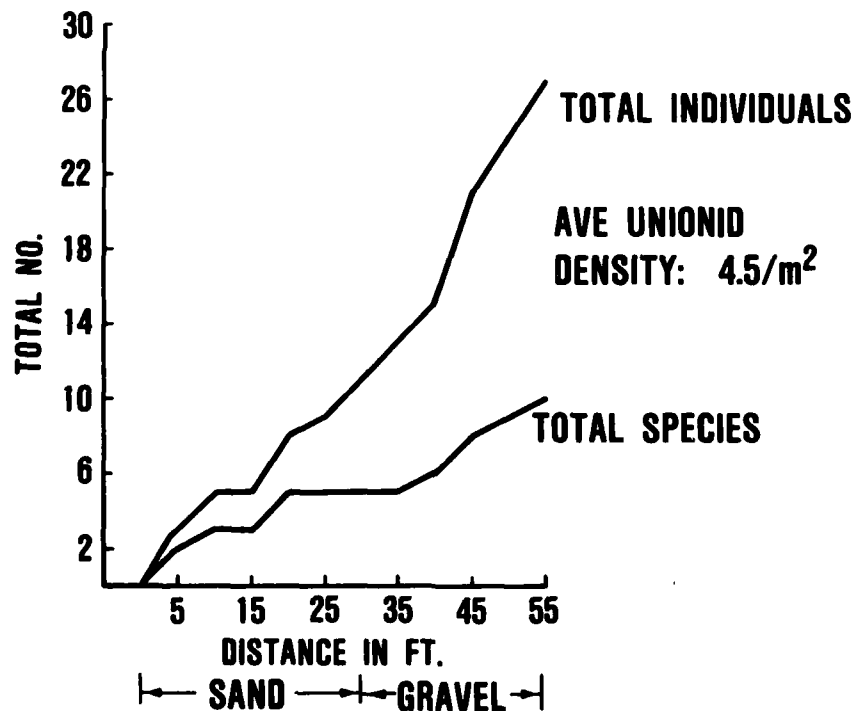


Figure 3. Total individuals and total species of unionids collected along a transect at Site II, Black River, mile 73.2, 12 September 1985



Figure 4. A well-vegetated stable bank on the Black River

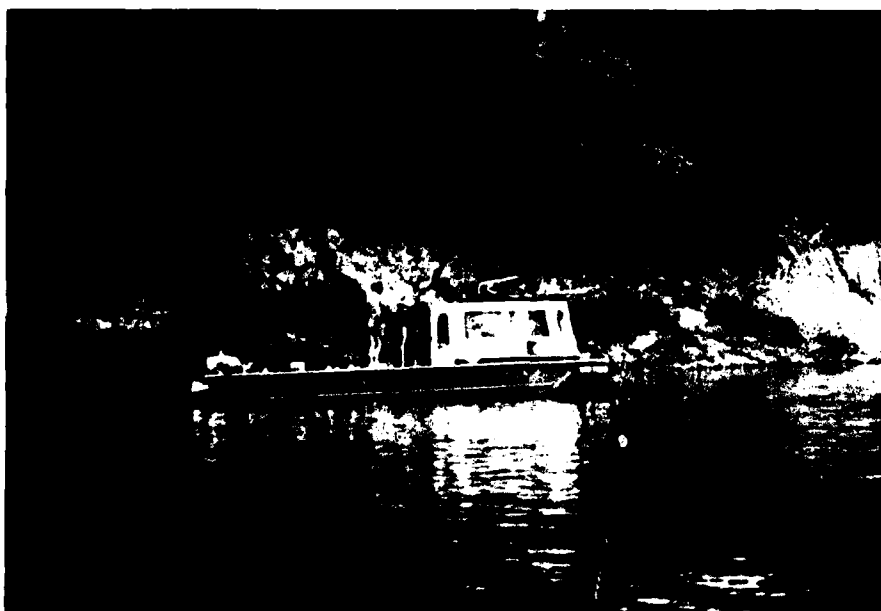


Figure 5. A steep, partially eroded bank on the Black River

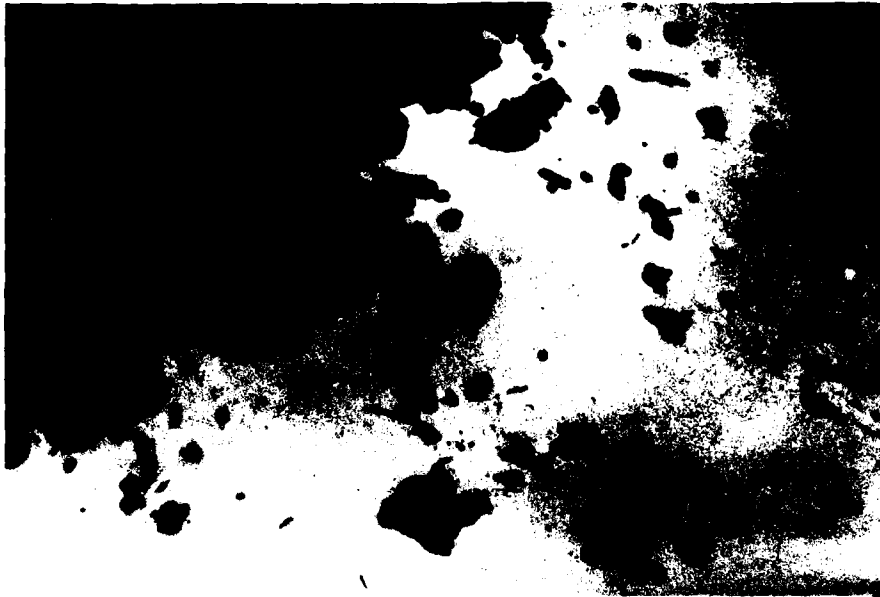


Figure 6. At a site near mile 75.0, detritus and worn shells were common



Figure 7. Live mussels were sorted and identified on the deck of the boat, then returned alive



Figure 8. Large numbers of the rabbit's foot *Quadmula cylindrica* were collected at mile 73.2 on the Black River



Figure 9. A well-worn valve of *L. orbiculata* (right) was collected on the Spring River near mile 7.0



Figure 10. *Quadrula pustulosa* (in hand) was abundant in the Black River



Figure 11. *Fusconaia ebena* (right) and *Amblyma plicata* (left) were abundant in the Black River

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